Student ID Number: ________

PRELIMINARY EXAMINATION

Department of Physics

University of Florida

Part B, January, 2018, 14:00–17:00

Instructions

1. You may use a calculator and CRC Math tables or equivalent. No other tables or aids are allowed or required. You may **NOT** use programmable calculators to store formulae.

   (a) All of the problems will be graded and will be tabulated to generate a final score. Therefore, you should submit work for all of the problems.

   (b) For convenience in grading please write legibly, use only one side of each sheet of paper, and work different problems on separate sheets of paper. The sheets for each problem will be stapled together but separately from the other two problems.

   (c) Your assigned student **ID Number**, the **Problem Number**, and the **Page Number** should appear in the upper right hand corner of each sheet. Do **NOT** use your name anywhere on the Exam.

   (d) All work must be shown to receive full credit. Work must be clear and unambiguous. Be sure that you hand your completed work to the Proctor.

   (e) Each problem is worth 10 points.

   (f) Following the UF Honor Code, your work on this examination must reflect your own independent effort, and you must not have given, nor received, any unauthorized help or assistance. If you have any questions, ask the Proctor.

University of Florida Honor Code: We, the members of the University of Florida community, pledge to hold ourselves and our peers to the highest standards of honesty and integrity. On all work submitted for credit by students at the University of Florida, the following pledge is either required or implied: *"On my honor, I have neither given nor received unauthorized aid in doing this assignment."*

DO NOT OPEN EXAM UNTIL INSTRUCTED

PRELIMINARY EXAMINATION
Department of Physics
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B1. **(Fry)** A sphere with charge q has a uniform charge density inside radius $r = a$ and zero outside.

(a) [**1 point**] What is the direction of the electric field? (Provide reasoning.)

(b) [**6 points**] What is the electric field strength inside and outside? What is the potential inside and outside? What is the electrostatic energy of this configuration?

(c) [**2 points**] The sphere expands with $da/dt = wa$ while maintaining a uniform charge distribution with the same constant total charge q. What is the time rate of change of the electric field? What is the displacement current density?

(d) [**1 point**] Is a nonzero magnetic field allowed? Is this consistent with (c)?

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B2. **(Klimenko)** A long cylinder of radius R is made of polarized dielectric. The polarization vector $\boldsymbol{P}$ is proportional to the radial vector $\boldsymbol{r}$, $\boldsymbol{P}=a\boldsymbol{r}$, where a is a positive constant. The cylinder rotates around its axis with an angular velocity ω ($\omega R << c$).

(a) [**3 points**] Find the electric field E at a radius r both inside and outside of the cylinder.

(b) [**4 points**] Find the magnetic field B at a radius r both inside and outside of the cylinder.

(c) Find the total electromagnetic energy stored per unit length of the cylinder.

[**1 point**] before the cylinder starts spinning.
[**2 points**] while it is spinning. Where did the extra energy come from?

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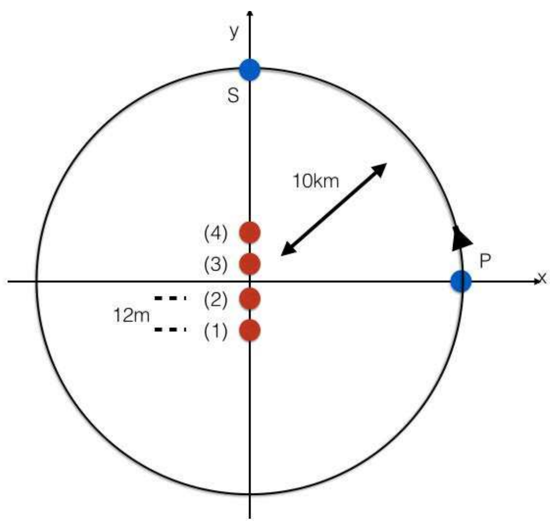
B3. **(Mueller)** Four identical radio broadcast towers lie along the y-axis and are separated by a distance d = 12 m each. All four towers broadcast at a frequency of 100 MHz (assume $c = 3 \times 10^8$m/s) with equal intensities of I_0. An observer walks in a circle with a radius of 10km around the towers and measures the intensity of the received radio waves. Use $10\,\text{km} \gg 12\,\text{m}$ to simplify.



(a) [**1 point**] What is the phase difference at point P along the x-axis between fields from neighboring towers if all four fields are generated in phase?

(b) [**1 point**] What is the phase difference at point S along the y-axis between the fields from adjacent towers?

(c) [**1 point**] What is the intensity in terms of I_0 at points P and S?

(d) [**3 points**] Now the observer starts walking from point P along the circle. How many maxima with (near) maximum intensity will she measure on the entire circle?

(e) [**4 points**] How many minima with (near) zero intensity will she encounter?